TABLE OF CONTENTS

Checking and repair: W-001/506

Product: QB- starting motor

Part no.: 0 001 510 ...

Continue: I01/2

TABLE OF CONTENTS

Continue: I02/1

SPECIAL FEATURES

These instructions describe repairs to starting motors of type QB 0 001 510..

- 24 V/9.0 kW

The multi-plate clutch can no longer be repaired. If damaged or worn, a multi-plate clutch is always to be renewed as a complete unit.

Continue: I02/2

SPECIAL FEATURES

QB starting motors as of date of manufacture FD 664 feature the following quality enhancement:
The busbar term. 30 is insulated on the inside of the starting motors by way of thermoplast encapsulation. Starting motors with the old non-insulated version must be converted to the new thermoplast-encapsulated version.
For this purpose, order new busbar in line with current replacement parts list.

Continue: I03/1

SPECIAL FEATURES

The checking of oilproof and waterproof starting motors is treated in separate instructions.

Starting motors may be operated with the combined start-locking and start-repeating relay.

Continue: I03/2

SPECIAL FEATURES

The functions of the combined start-locking and start-repeating relay are as follows:

* Start-locking function (cutout in the event of motor self-start, prevention of starting-motor actuation with engine running and after interruption of start command until engine has stopped)

* Start-repeating function (automatic repetition of starting-motor actuation until pinion has engaged)

Continue : I01/1

STRUCTURE, USAGE

User prompting is provided on every page e.g.:
- Continue: I 17/1
- Continue: II 18/1 Fig.: II 17/2

Brief instructions may include several rows of coordinates.
I../. = first coordinate row
II../. = second coordinate row
III../. = third coordinate row
etc.

.../1 = upper coordinate half
.../2 = lower coordinate half

Continue: I01/1

GENERAL

Expert repairs can only be performed with the prescribed tools and properly functioning measuring instruments. We therefore recommend that exclusive use be made of the tools indicated.

The use of incorrect and unsuitable tools and testers may result in injury and could cause damage to the product and components.

Continue: I05/2

GENERAL

Make exclusive use of service parts as per the replacement parts list for the type of starting motor concerned.

To guarantee proper functioning, use must be made of the lubricants prescribed in these instructions before and during assembly.

Take care to ensure cleanliness when performing repair work.

Continue: I01/1

SAFETY PRECAUTIONS

Component cleaning:
Only use compressed air (max. 4 bar) and a clean rag to clean armatures, excitation windings, commutator end shields, relays and the shaft ends of the multi-plate clutch. Do not use cleaning fluids.

Other parts, such as intermediate bearings and drive-end bearings, can be washed out in commercially available cleaners which are not readily flammable.
Take care not to inhale vapors.

Continue: I06/2

SAFETY PRECAUTIONS

Danger of fire: Avoid naked flames, light and sparks.

ATTENTION:
Thoroughly dry cleaned components, as gases may subsequently form in the sealed starting motor and cause an explosion.

Always use tools indicated. The use of incorrect and unsuitable tools and testers could lead to injury.

Continue: I07/1

SAFETY PRECAUTIONS

Pay attention to the following safety regulations:

* Order governing work with flammable liquids (VbF) as issued by the German Ministry of Labor (BmA).
* Accident prevention regulations for electrical systems and equipment.
* Safety regulations for handling chlorinated hydrocarbons:
  - For companies: ZH 1/222
  - For employees: ZH 1/129

  as issued by the Main Association for Professional Liability Insurance Associations (Central Association for Accident Prevention and Industrial Medicine`, Langwartweg 103, 53129 Bonn.

Continue: I07/2

SAFETY PRECAUTIONS

Outside Germany, pay attention to the appropriate local regulations.

Skin protection:
To prevent skin irritation when working with oil and grease, apply hand cream before starting work and wash hands in soap and water afterwards.

Continue: I01/1

TESTERS, FIXTURES, TOOLS

Listed in the following are all the tools required for repairing starting motors of type QB.

Some of the tools required have to be made in line with the drawings provided.

Where tools used to be ordered by way of type designation, this is indicated in parentheses.

Continue: I08/2

TESTERS, FIXTURES, TOOLS

Interturn-short-circuit tester:	0 986 619 110
Test prods:	0 986 619 114
Alternator tester WPG 012.00: (or Motortester)	0 684 201 200
Magnetic instrument stand:	4 851 601 124
Dial indicator:	1 687 233 011
Torque wrench (0...70 Nm):	comm. avail.

Continue: I09/1

TESTERS, FIXTURES, TOOLS

Inserter and extractor for stud bolts:	comm. avail.
Spring balance (0...160 N):	comm. avail.
Torquemeter (0.15...0.80 Nm):	0 986 617 206 (KDAL 5485)
(33...300 Nm):	0 986 617 166 (KDAL 5476)
Clamping support:	0 986 619 362 (KDAW 9999)

Continue: I09/2

TESTERS, FIXTURES, TOOLS

Assembly wrench:	0 986 617 198 (KDAL 5483)
Puller for needle bushing in armature:	0 986 617 233 (KDAL 5492)
Extractor 18.1 mm for needle bushing in armature:	0 986 617 240 (KDAL 5492/0/7)
Pressing-in mandrel for needle bushing in armature:	0 986 617 185 (KDAL 5479)

Continue: I10/1

TESTERS, FIXTURES, TOOLS

Jaw-type extractor for deep-groove ball bearing at bearing end plate:	comm. avail.
Pole-shoe screwdriver:	0 986 619 393 (KDAW 9999/7)
Torx T50 bit insert with hexagon 5/16":	comm. avail.

Continue: I10/2

TESTERS, FIXTURES, TOOLS

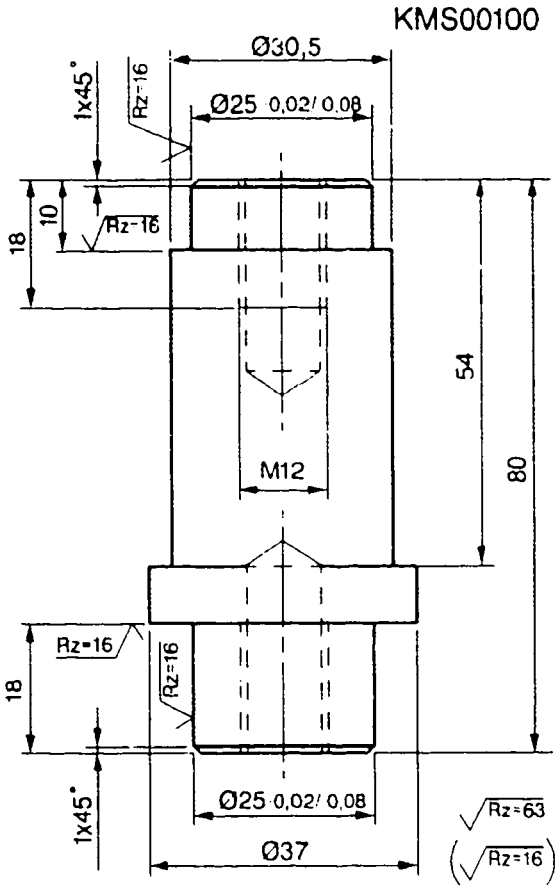
Threaded pin with cone:	0 986 619 250
Spring collet 36.3 mm:	0 986 619 242
Driving-in mandrel diameter:	101,15 - 0,05 mm (improvisation)

Continue: I11/1

TESTERS, FIXTURES, TOOLS

Pressing-out and pressing-in mandrel for bushing in commutator end shield: (improvisation)

Continue: I12/1 Fig.: I11/2

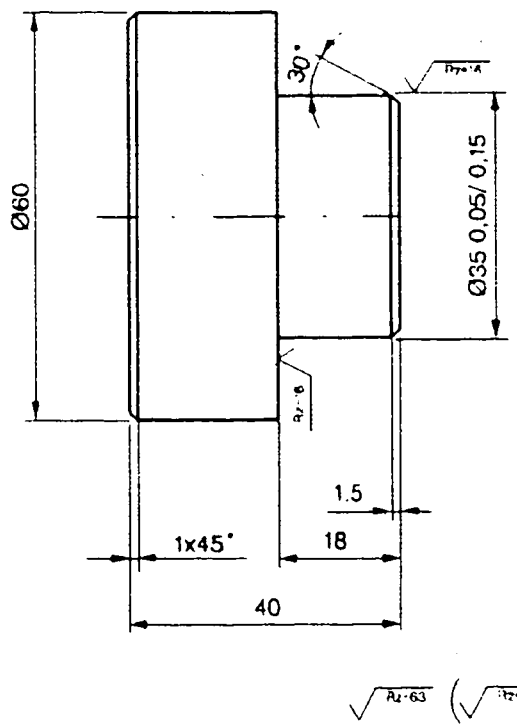


TESTERS, FIXTURES, TOOLS

Pressing-out and pressing-in mandrel for cylindrical roller bearing in drive-end bearing: (improvisation)

Continue: I13/1 Fig.: I12/2

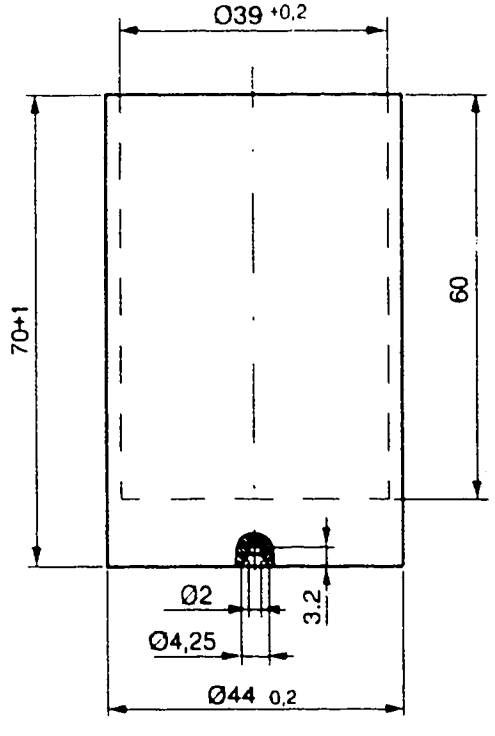
KMS00101



Centering sleeve for
jaw-type puller for
removing deep-groove
ball bearing from
bearing end plate: (improvisation)

Continue: I14/1 Fig.: I13/2

KMS00102

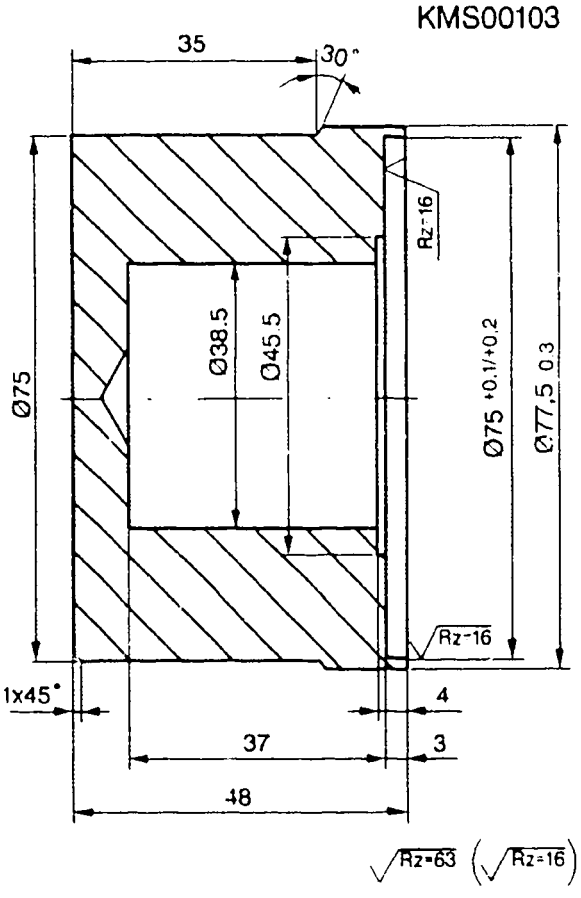


√Rz=63

TESTERS, FIXTURES, TOOLS

Thrust piece for pressing
deep-groove ball
bearing onto
bearing end plate: (improvisation)

Continue: I15/1 Fig.: I14/2

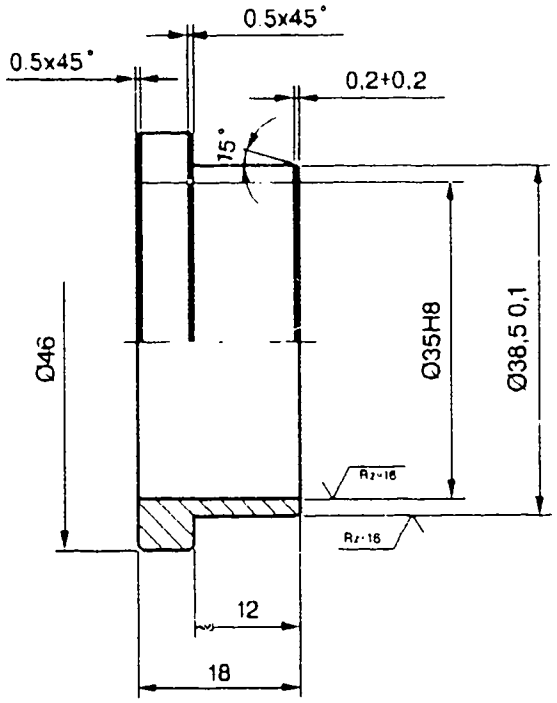


TESTERS, FIXTURES, TOOLS

Sleeve for supporting
multi-plate clutch
when testing over-
load protection: (improvisation)

Continue: I16/1 Fig.: I15/2

KMS00104



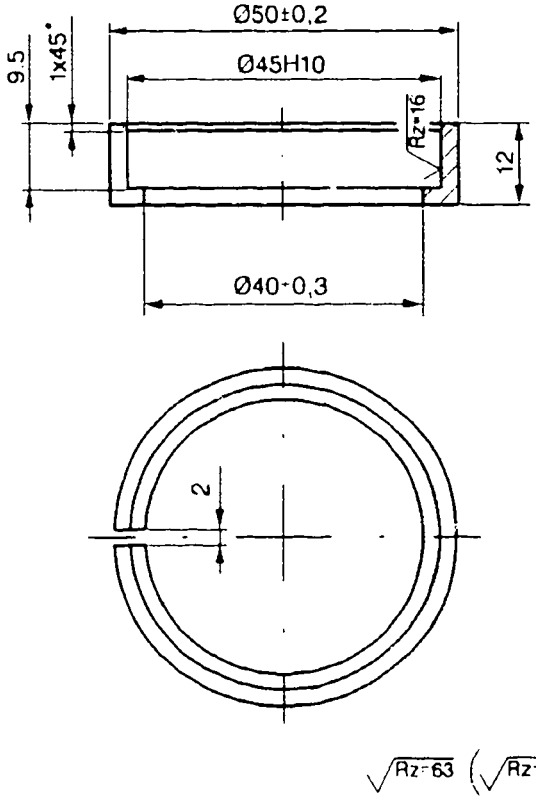
$\sqrt{Rz\ 63}$ $\left(\sqrt{Rz\ 16}\right)$

TESTERS, FIXTURES, TOOLS

Clamping sleeve for
holding armature in
three-jaw chuck: (improvisation)

Continue: I17/1 Fig.: I16/2

KMS00105

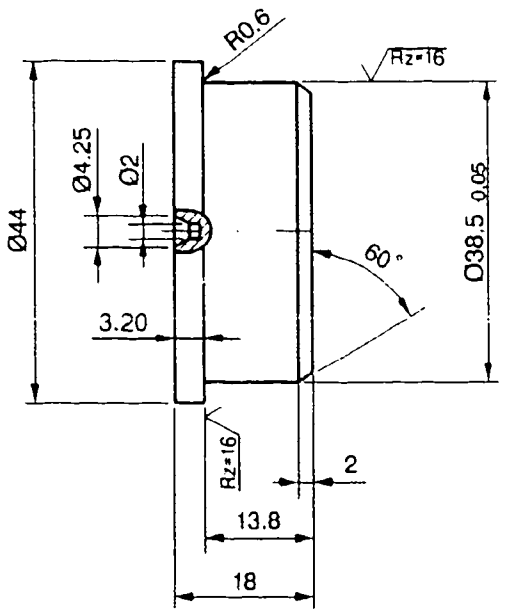


$\sqrt{Rz=63}$ $(\sqrt{Rz=16})$

Thrust piece for holding armature on undercutting saw: (improvisation)

Continue: I01/1 Fig.: I17/2

KMS00106



$\sqrt{Rz=63}$ $\left(\sqrt{Rz=16}\right)$

TEST SPECIFICATIONS AND SETTINGS

Commutator minimum diameter:	59,0 mm
Brush contact force:	21...22 N
Armature axial play:	0,2...0,4 mm
Clutch nut axial play:	0,9...1,8 mm
Starting force of helical spring on engaging shaft:	50...60 N
Final force of helical spring on engaging shaft:	71...81 N
Eccentricity	
- Commutator:	max. 0,03 mm
- Laminated core:	max. 0,05 mm

Continue: I18/2

TEST SPECIFICATIONS AND SETTINGS

New carbon-brush dimension:	26,5 mm
Minimum carbon-brush dimension:	16,5 mm
Multi-plate clutch response torque of overload protection:	200...240 Nm
Overrunning torque:	0,3...0,5 Nm

Continue: I19/1

TEST SPECIFICATIONS AND SETTINGS

Resistance
Shunt winding: 1960...2160 mOhm

Resistance
Auxiliary winding: 410... 460 mOhm

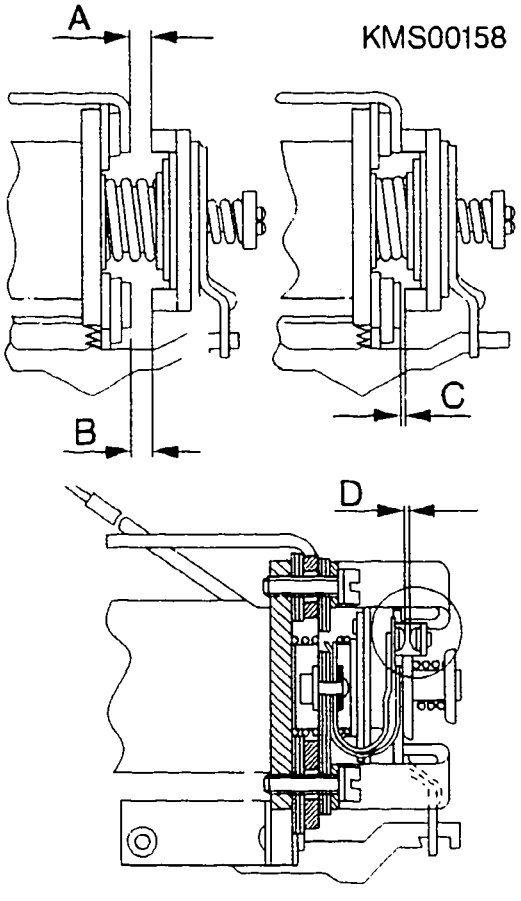
Continue: I20/1

TEST SPECIFICATIONS AND SETTINGS

Test specifications and settings
for control relay 0 331 100

Dimensions A and B:	min. 2,0 mm
Dimension C:	0,8...1,2 mm
Dimension D:	min. 1,5 mm

Continue: I01/1 Fig.: I20/2



TIGHTENING TORQUES

Pinion attachment:	38...43 Nm
Bearing end plate attachment:	7...8,5 Nm
Drive-end bearing attachment:	9...11 Nm
Commutator end shield attachment:	7,8...9,7 Nm
Control-relay attachment:	11...16 Nm
Starting-motor solenoid attachment:	9,8...14 Nm
Pole-shoe screws:	41...51 Nm
Terminal 30 (M10):	16...20 Nm
Terminal 30 (M12):	25...31 Nm
Terminal 31 (M10):	16...20 Nm
Terminal 31 (M12):	25...31 Nm
Terminal 48 (M5):	2,6...3,5 Nm
Terminal 50 (M6):	3,5...4,5 Nm

Continue: I01/1

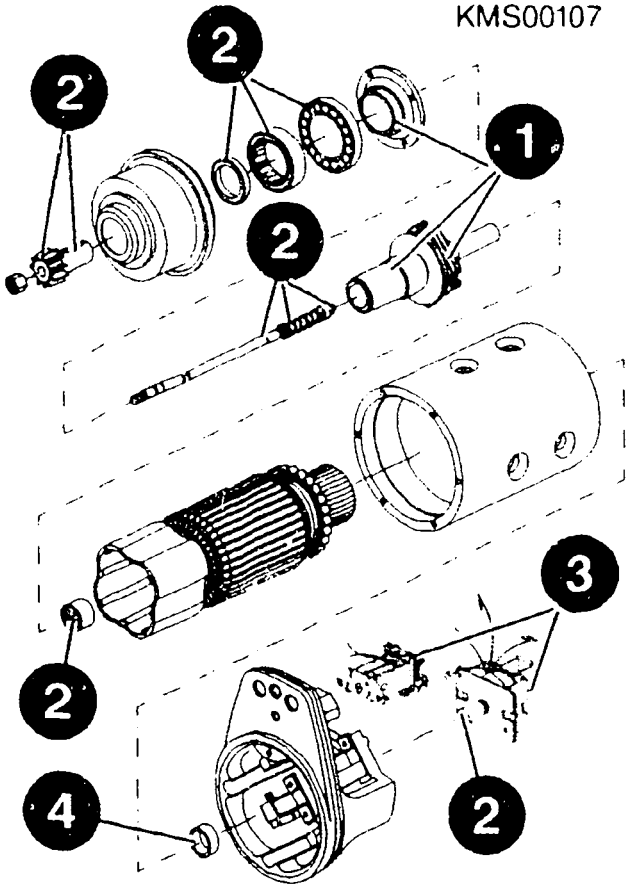
LUBRICANTS/LUBRICATION CHART

General:
Commutator and carbon brushes are to be kept free of grease and oil.
Greased parts are to be degreased before relubricating them.

(1):	Ft2 v 1	5 700 080 000
(2):	Grease VS 10832	5 932 240 000
(3):	Gleitmo 1580V	5 996 328 000
(4):	Shell Tellus oil	comm. avail.

Continue: I01/1 Fig.: I22/2

KMS00107



ELECTRICAL CONNECTIONS AND CIRCUIT DIAGRAMS

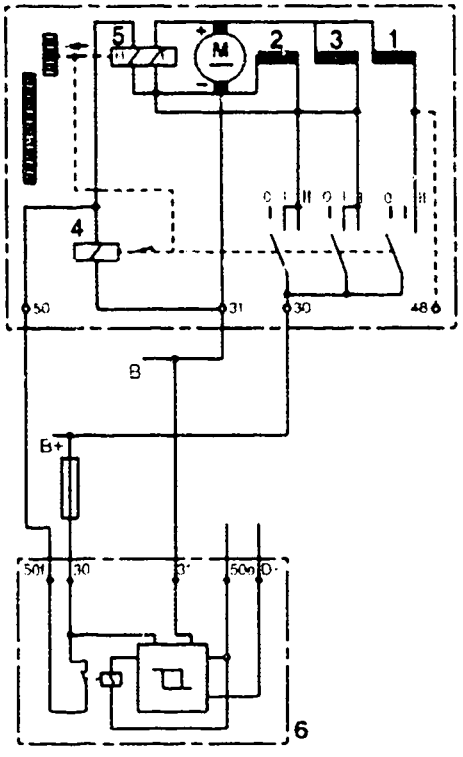
For operation with start-locking and start-repeating relay

1 = Excitation winding
2 = Shunt winding
3 = Auxiliary winding
4 = Control relay
5 = Starting-motor solenoid
6 = Start-locking and start-repeating relay

I = Shunt winding in series with armature (as auxiliary excitation winding)
II = Shunt winding in parallel with armature (as speed limitation)

Continue: I24/1 Fig.: I23/2

KMS00108



ELECTRICAL CONNECTIONS AND CIRCUIT DIAGRAMS

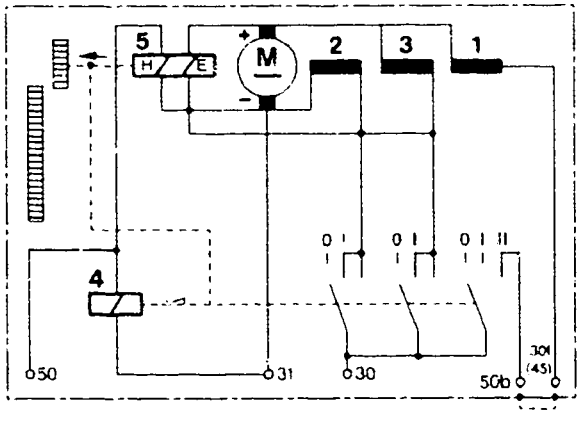
For parallel operation of two starting motors

1 = Excitation winding
2 = Shunt winding
3 = Auxiliary winding
4 = Control relay
5 = Starting-motor solenoid

I = Shunt winding in series with armature (as auxiliary excitation winding)
II = Shunt winding in parallel with armature (as speed limitation)

Continue: I01/1 Fig.: I24/2

KMS00109



STARTING-MOTOR DISASSEMBLY TABLE

Continue: I01/1

STARTING-MOTOR DISASSEMBLY

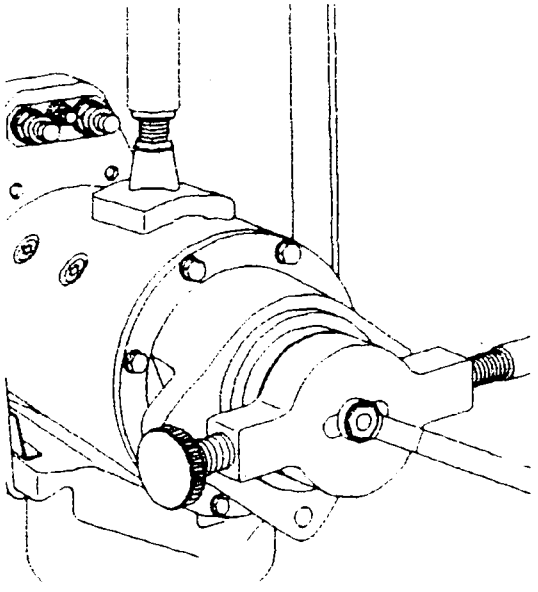
Disassembling pinion

Clamp starting motor in clamping support. Loosen Unistop pinion-fastening nut. Counterhold with assembly wrench.
Remove pinion.

Clamping support:	0 986 619 362
Assembly wrench:	0 986 617 198

Continue: I27/1 Fig.: I26/2

KMS00110



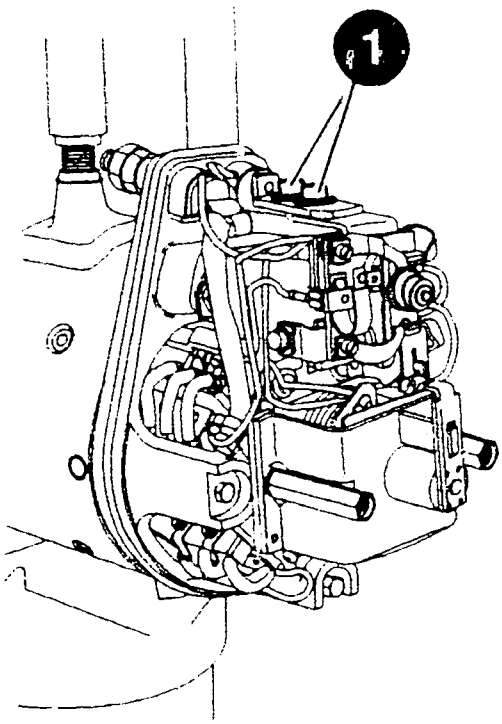
STARTING-MOTOR DISASSEMBLY

Disassembling control relay and starting-motor solenoid

Remove protective cap.
Loosen term. 30/31/50.
Lift off insulating caps (1) and loosen fastening screws.
Remove connecting bar term. 30.
Unsolder leads from term. 50 and remove term. 50.
Pay attention to O-rings and insulating sleeves. Unfasten all connections at control relay and carbon brushes.

Continue: I28/1 Fig.: I27/2

KMS00111



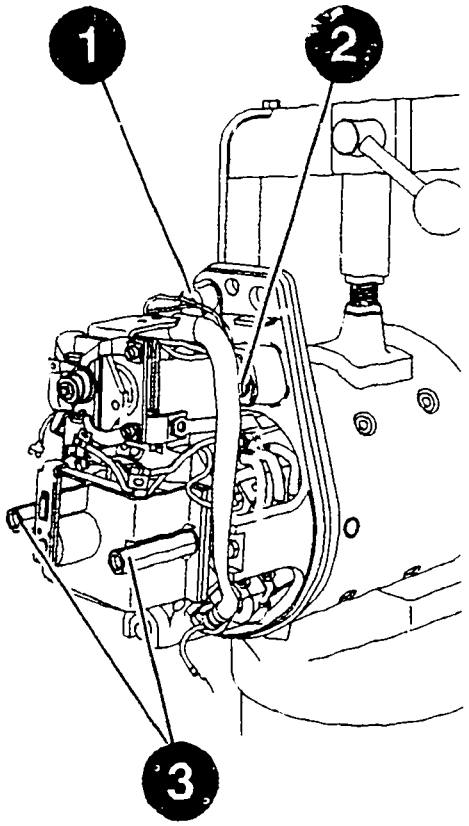
STARTING-MOTOR DISASSEMBLY

Disassembling control relay and starting-motor solenoid

Remove term. 31 (1) with flexible negative bars. Pay attention to O-ring and insulating sleeve.
Loosen fastening screws (2) and remove control relay.
Loosen securing bolt (3) and remove starting-motor solenoid.
ATTENTION: DANGER OF INJURY
Engaging shaft is spring-pretensioned and shoots out of the armature on disassembling the starting-motor solenoid.

Continue: II01/1 Fig.: I28/2

KMS00112



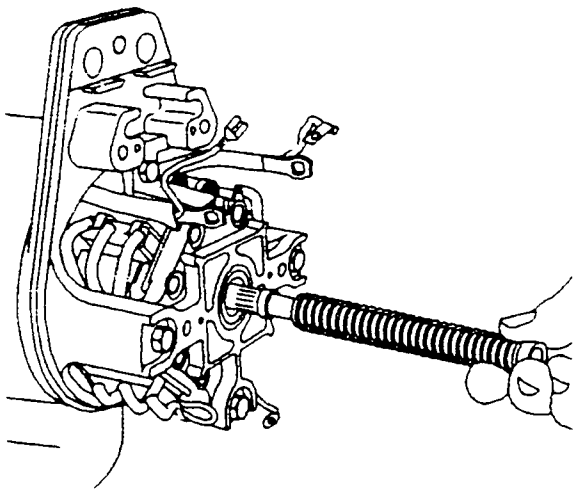
STARTING-MOTOR DISASSEMBLY

Disassembling engaging shaft

Pull engaging shaft on commutator end out of armature.

Continue: II02/1 Fig.: II01/2

KMS00113



STARTING-MOTOR DISASSEMBLY

Disassembling carbon brushes

Mark installation position of carbon brushes.
Use suitable tool to lift springs and remove carbon brushes.

Continue: II03/1

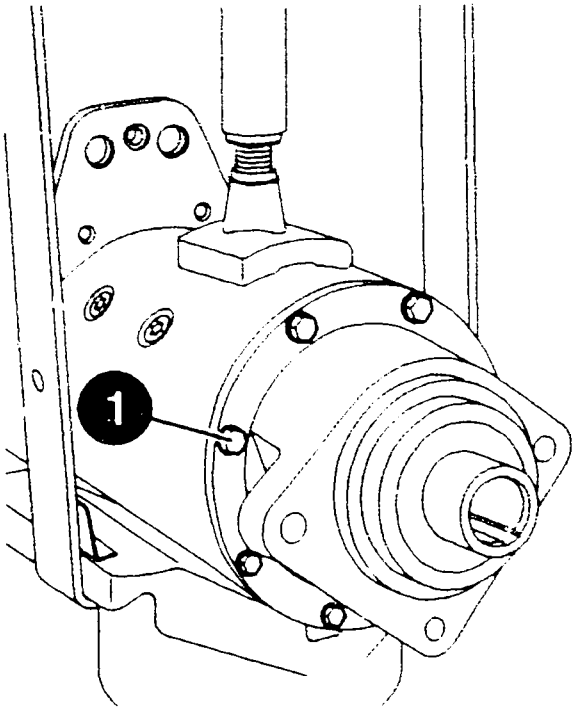
STARTING-MOTOR DISASSEMBLY

Disassembling drive-end bearing

Mark position of drive-end bearing.
Loosen bearing fastening screws (1).

Continue: II04/1 Fig.: II03/2

KMS00114



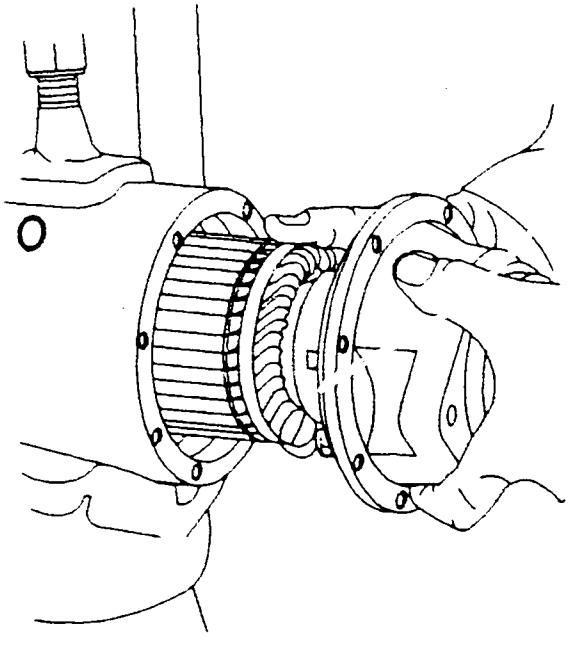
STARTING-MOTOR DISASSEMBLY

Disassembling drive-end bearing

Pull drive-end bearing complete with armature out of stator frame.
Pay attention to shims on commutator end of armature shaft.
Pull armature out of drive-end bearing.

Continue: II05/1 Fig.: II04/2

KMS00115

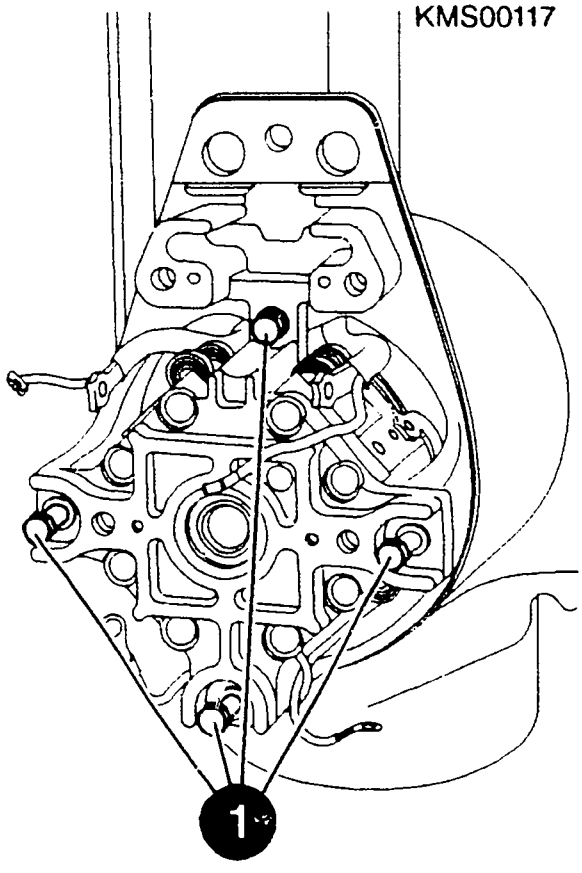


STARTING-MOTOR DISASSEMBLY

Disassembling commutator end shield

Loosen fastening screws (1) and pull off commutator end shield.
Pay attention to shims.
Take care not to damage insulation of protruding winding ends (bend slightly if necessary).

Continue: II06/1 Fig.: II05/2



STARTING-MOTOR DISASSEMBLY

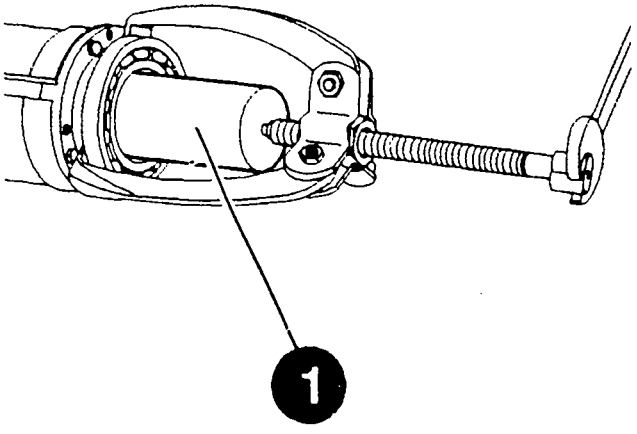
Disassembling intermediate bearing

Clamp armature in clamping support.
Slip centering sleeve (1) onto drive spindle.
Use commercially available jaw-type puller to remove deep-groove ball bearing from bearing end plate.

Clamping support:	0 986 619 362
Jaw-type puller:	comm. avail.
Centering sleeve for jaw-type puller:	(improvisation)

Continue: II07/1 Fig.: II06/2

KMS00118

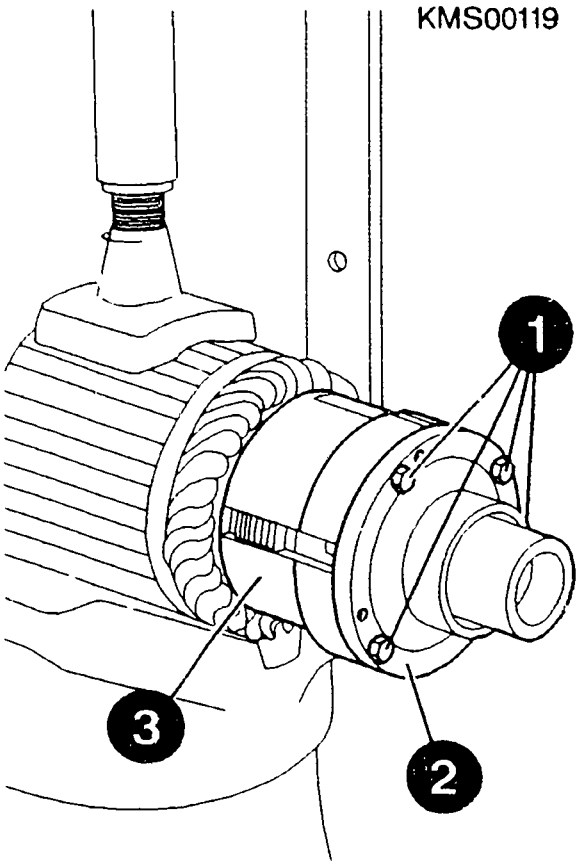


STARTING-MOTOR DISASSEMBLY

Disassembling multi-plate clutch

Loosen fastening screws (1) of bearing end plate (2).
Remove end plate from clutch housing (3).

Continue: II08/1 Fig.: II07/2



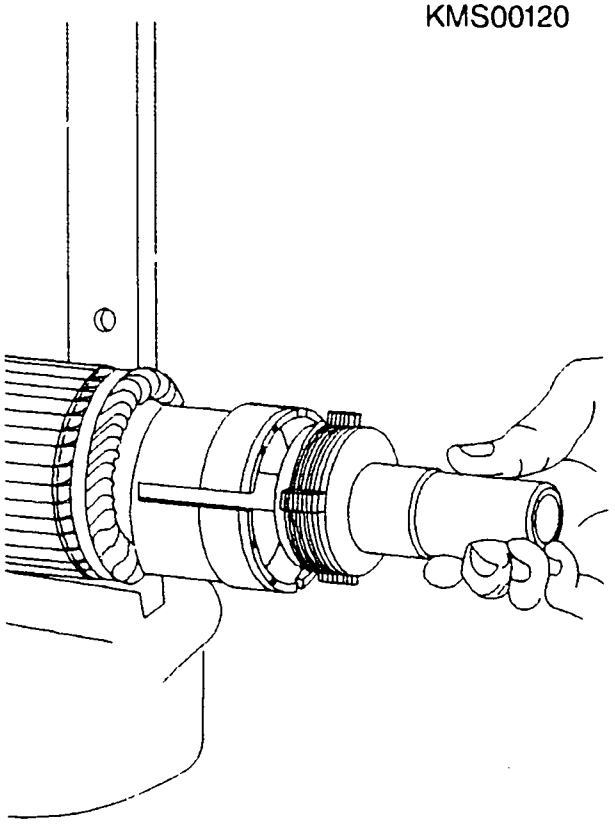
STARTING-MOTOR DISASSEMBLY

Disassembling multi-plate clutch

Pull complete multi-plate clutch out of clutch housing.

Continue: I01/1 Fig.: II08/2

KMS00120



CLEANING OF COMPONENTS

Component cleaning:
Only use compressed air (max. 4 bar) and a clean rag to clean armatures, excitation windings, commutator end shields, relays and the shaft ends of the multi-plate clutch. Do not use cleaning fluids.

Other parts, such as intermediate bearings and drive-end bearings, can be washed out in commercially available cleaners which are not readily flammable.
Take care not to inhale vapors.

Continue: II09/2

CLEANING OF COMPONENTS

Danger of fire: Avoid naked flames, light and sparks.

ATTENTION:
Thoroughly dry cleaned components, as gases may subsequently form in the sealed starting motor and cause an explosion.

Continue: II10/1

CLEANING OF COMPONENTS

Pay attention to the following safety regulations:

* Order governing work with flammable liquids (VbF) as issued by the German Ministry of Labor (BmA).
* Accident prevention regulations for electrical systems and equipment.
* Safety regulations for handling chlorinated hydrocarbons:
  - For companies: ZH 1/222
  - For employees: ZH 1/129

  as issued by the Main Association for Professional Liability Insurance Associations (Central Association for Accident Prevention and Industrial Medicine), Langwartweg 103, 53129 Bonn.

Continue: II10/2

CLEANING OF COMPONENTS

Outside Germany, pay attention to the appropriate local regulations.

Continue: I01/1

CHECKING, REPAIR TABLE

Continue: II11/2

CHECKING, REPAIR TABLE

Continue: I01/1

CHECKING AND REPAIRING COMPONENTS

Checking pinion

Check pinion for running marks and chipping.
Replace if necessary.

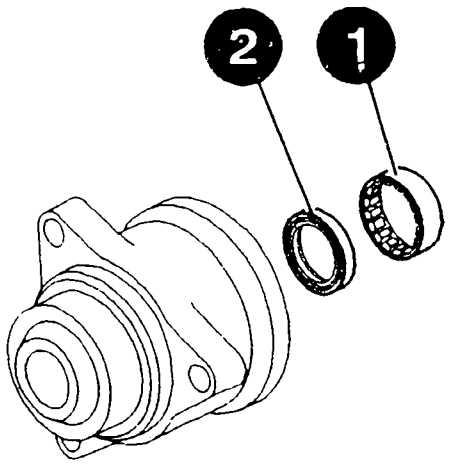
Continue: II13/1

Checking drive-end bearing

Cylindrical roller bearing (1) and radial lip-type oil seal (2) must always be renewed.

Continue: II14/1 Fig.: II13/2

KMS00121



CHECKING AND REPAIRING COMPONENTS

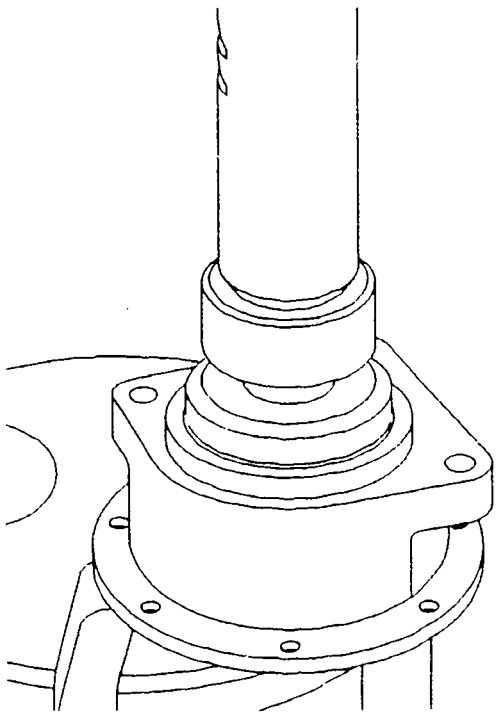
Checking drive-end bearing

Removal: Insert spring collet from inside in cylindrical roller bearing and tension with threaded pin.
Attach pressing-out and pressing-in mandrel from outside to spring collet and press out cylindrical roller bearing.
Press out radial lip-type oil seal.

Threaded pin:	0 986 619 250
Spring collet 36.3 mm:	0 986 619 242
Pressing-out and pressing-in mandrel for cylindrical roller bearing in drive-end bearing:	(improvisation)

Continue: II15/1 Fig.: II14/2

KMS00122



CHECKING AND REPAIRING COMPONENTS

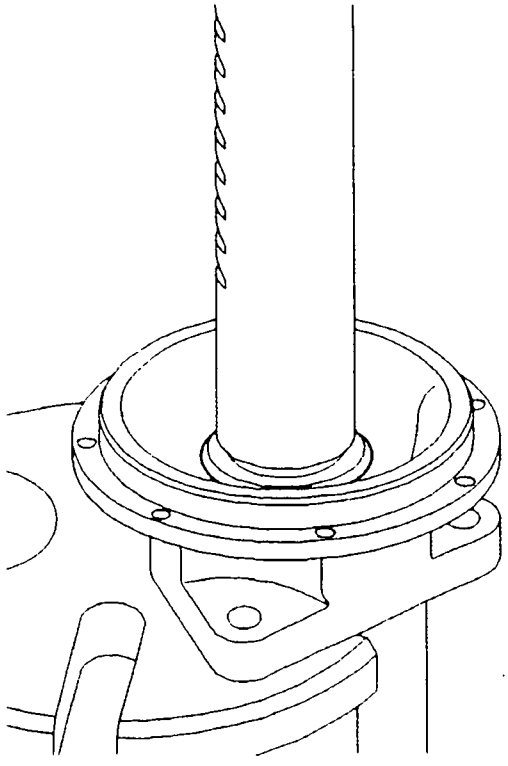
Checking drive-end bearing

Installation: Use pressing-out and pressing-in mandrel to press new radial lip-type oil seal into drive-end bearing.
Use pressing-out and pressing-in mandrel to press new cylindrical roller bearing into drive-end bearing.
Grease bearing.

Pressing-out and pressing-in mandrel for cylindrical roller bearing in drive-end bearing: (improvisation)
Grease VS 10832: 5 932 240 000

Continue: II16/1 Fig.: II15/2

KMS00123



CHECKING AND REPAIRING COMPONENTS

Checking intermediate bearing

Check deep-groove ball bearing of intermediate bearing for damage and smooth running.
Replace if necessary.

Continue: II17/1

CHECKING AND REPAIRING COMPONENTS

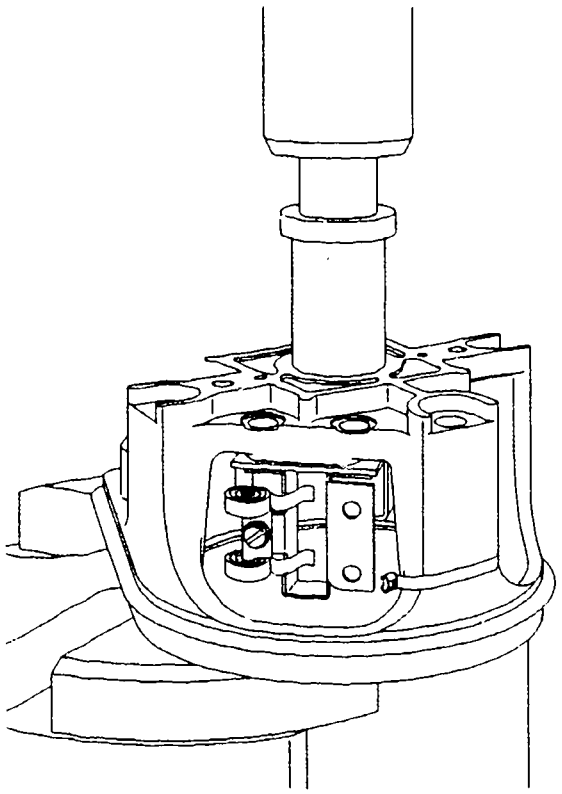
Checking commutator end shield

Check bushing for damage and running marks.
Removal:
Use pressing-out and pressing-in mandrel to press out bushing.

Pressing-out and pressing-in mandrel for bushing in commutator end shield: (improvisation)

Continue: II18/1 Fig.: II17/2

KMS00125



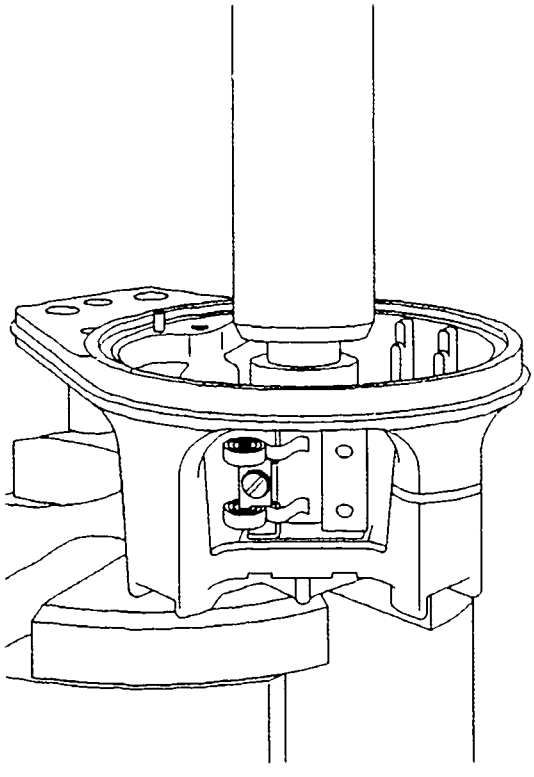
Checking commutator end shield

Installation: Use reversed pressing-out and pressing-in mandrel to press in new bushing.
ATTENTION: Bushing must have been impregnated beforehand for 8 hours with Shell Tellus oil.

Pressing-out and pressing-in mandrel for bushing in commutator end shield:	(improvisation)
Shell Tellus oil:	comm. avail.

Continue: II19/1 Fig.: II18/2

KMS00126



CHECKING AND REPAIRING COMPONENTS

Checking commutator end shield

Check all carbon-brush holders insulated against commutator end shield for ground short.
("+" carbon-brush holders/insulated
"-" carbon-brush holders)

Ground-short test voltage: 80 V

Continue: II20/1

CHECKING AND REPAIRING COMPONENTS

Checking carbon brushes

Check tightness of connections.
Check bearing surfaces for scoring and chipping. Replace carbon brushes if minimum dimension has been reached.

New carbon-brush dimension:	26,5 mm
Min. carbon-brush dimension:	16,5 mm

Continue: II21/1

CHECKING AND REPAIRING COMPONENTS

Checking control relay and starting-motor solenoid

Check tight ground connection of control relay and starting-motor solenoid.
Individual components cannot be replaced. Replace scorched or damaged control relays and solenoids.
Always use the service parts given in the replacement parts list.

Continue: II22/1

CHECKING AND REPAIRING COMPONENTS

Checking control relay and starting-motor solenoid

QB starting motors feature the following quality enhancement:
The busbar term. 30 is insulated on the inside of the starting motors by way of thermoplast encapsulation. Starting motors with the old non-insulated version must be converted to the new thermoplast-encapsulated version.
For this purpose, order new busbar in line with current replacement parts list.

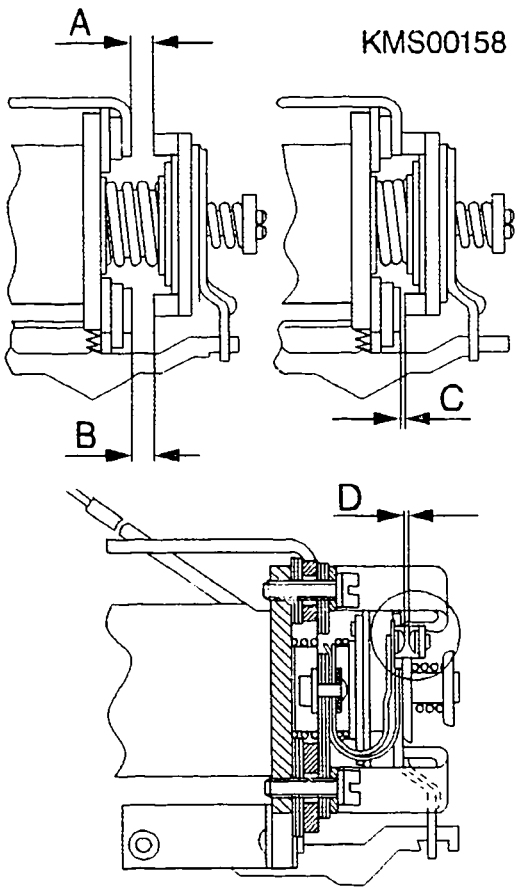
Continue: II23/1

CHECKING AND REPAIRING COMPONENTS

Checking control relay and starting-motor solenoid

Control relay deenergized
dimensions A and B
0 331 100 .. min. 2,0 mm

Continue: II24/1 Fig.: II23/2



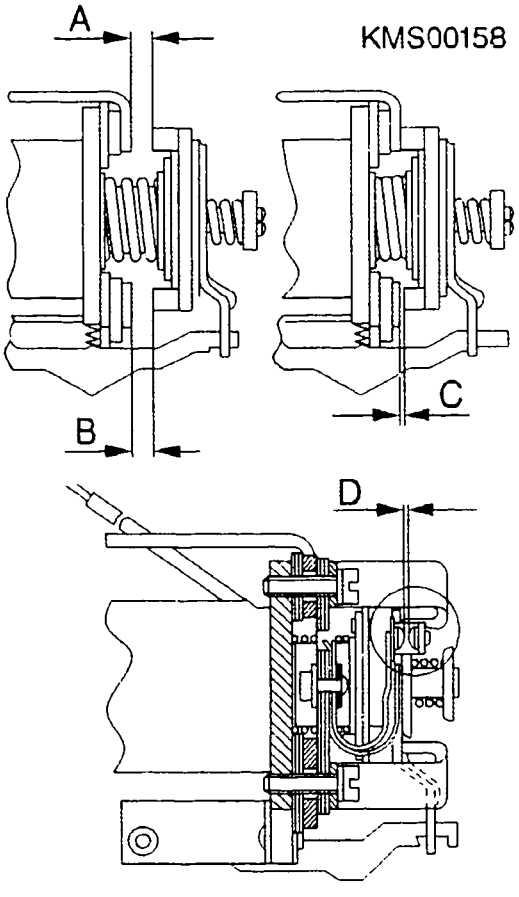
CHECKING AND REPAIRING COMPONENTS

Checking control relay and starting-motor solenoid

Armature retracted, release lever in locked position
dimension C
0 331 100 .. 0,8...1,2 mm

Auxiliary contacts, control relay deenergized
dimension D
0 331 100 .. min. 1,5 mm

Continue: II25/1 Fig.: II24/2



CHECKING AND REPAIRING COMPONENTS

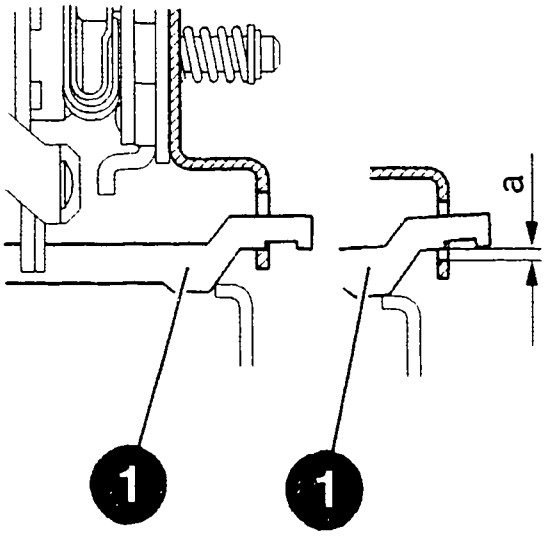
Adjusting control relay and starting-motor solenoid

Clean all contacts with contact file.

Check on wear reserve
Release lever (1) (catch) and latching lever of control relay in end position (primary current):
Dimension a: 2,0...3,0 mm

Continue: II26/1 Fig.: II25/2

KMS00075

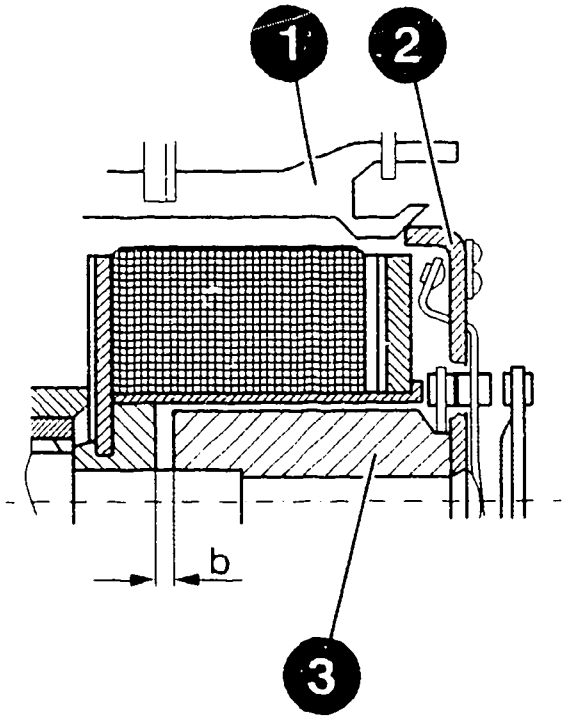


Adjusting control relay and starting-motor solenoid

Actuator lever (2) of solenoid in release position (contact with release lever (1)). Remaining travel of armature (3):
Dimension b: 1,0...2,0 mm

Continue: II27/1 Fig.: II26/2

KMS00124



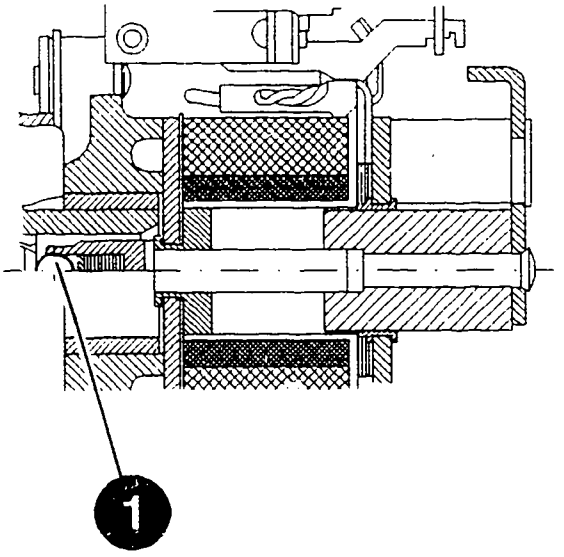
Checking return force of helical spring on engaging shaft

This is performed with starting-motor assembled.
It must be possible to push pinion back into rest position with spring action via rubber buffer in thrust piece of starting-motor solenoid.
Engaging shaft must be seated on ball (1) in starting-motor solenoid in rest position.

Initial force:	50...60 N
Final force:	71...81 N

Continue: II28/1 Fig.: II27/2

KMS00077



CHECKING AND REPAIRING COMPONENTS

Checking multi-plate clutch

If the value for the axial play of the clutch nut, the overrunning torque or the response torque of the overload protection is outside the stated range, the entire multi-plate clutch must be replaced.

Axial play:	0,9...1,8 mm
Overrunning torque:	0,3...0,5 Nm
Response torque, overload protection:	200...240 Nm

Continue: III01/1

CHECKING AND REPAIRING COMPONENTS

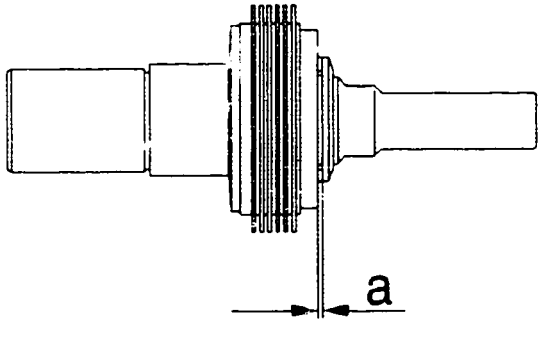
Checking multi-plate clutch

Check axial play of clutch nut.

Dimension a: 0,9...1,8 mm

Continue: III02/1 Fig.: III01/2

KMS00151



CHECKING AND REPAIRING COMPONENTS

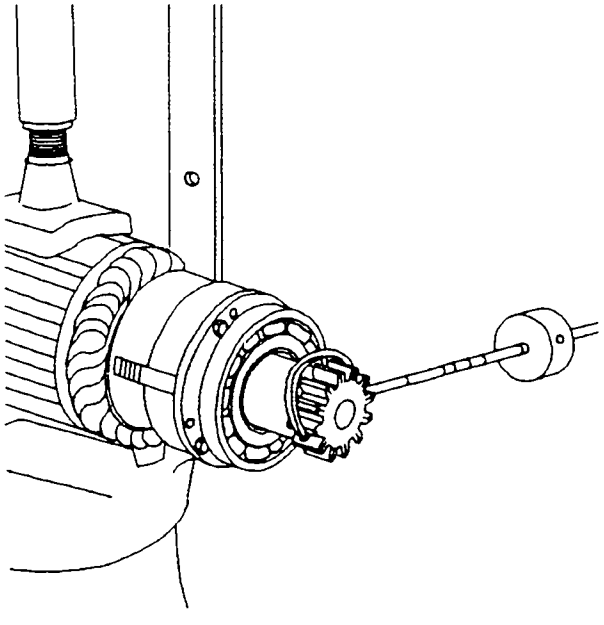
Checking multi-plate clutch

Check overrunning torque of clutch.
Clamp armature with clutch fitted in clamping support.
Insert pinion in drive spindle.
Check overrunning torque of multi-plate clutch with torquemeter in non-friction direction.

Torquemeter:	0 986 617 206
Overrunning torque:	0,3...0,5 Nm

Continue: III03/1 Fig.: III02/2

KMS00127



CHECKING AND REPAIRING COMPONENTS

Checking multi-plate clutch

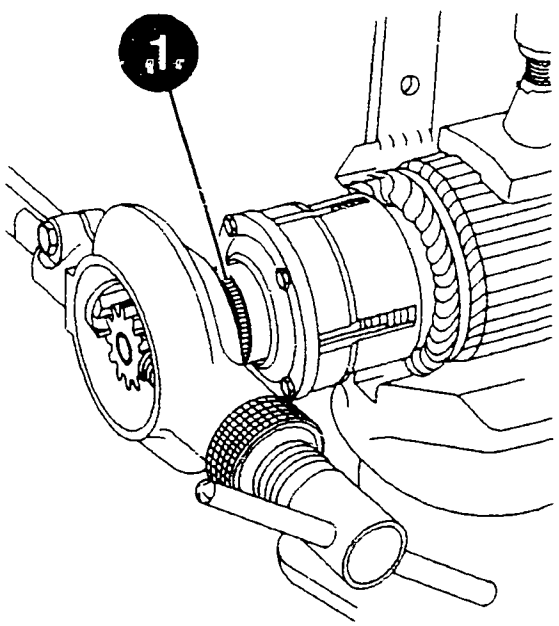
Check clutch overload protection.
Slip support sleeve (1) over drive spindle into intermdiate bearing and insert pinion in drive spindle.
Use torquemeter to check response torque in friction direction.

Torquemeter:	0 986 617 166
Support sleeve:	(improvisation)

Response torque, overload protection:	200...240 Nm

Continue: III04/1 Fig.: III03/2

KMS00128

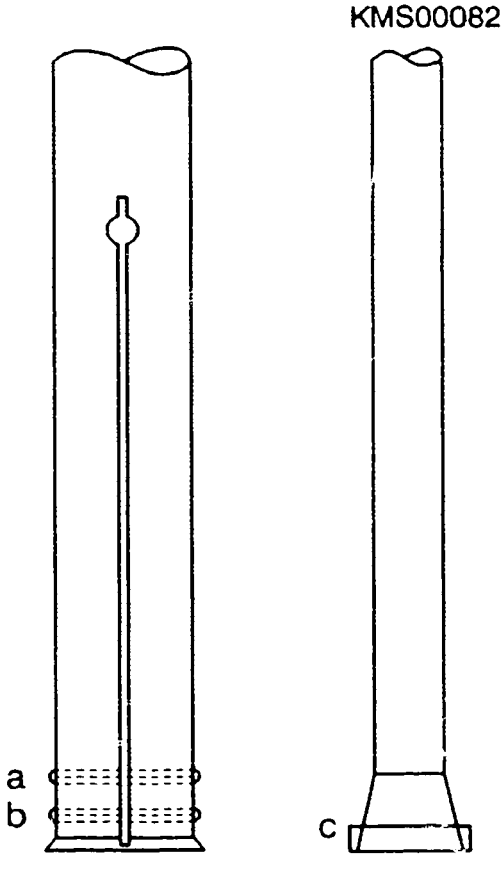


CHECKING AND REPAIRING COMPONENTS

Checking needle bushing in armature

Only replace needle bushing if bearing surface of bushing on drive spindle shows signs of wear, running-in or seizure marks, scoring or temperature-induced discoloration.
The two annular lugs "a" and "b" have to be ground off at the spring collet before extracting the needle bushing.
The limit stop "c" at the cone of the extractor must be tapered.

Continue: III05/1 Fig.: III04/2



CHECKING AND REPAIRING COMPONENTS

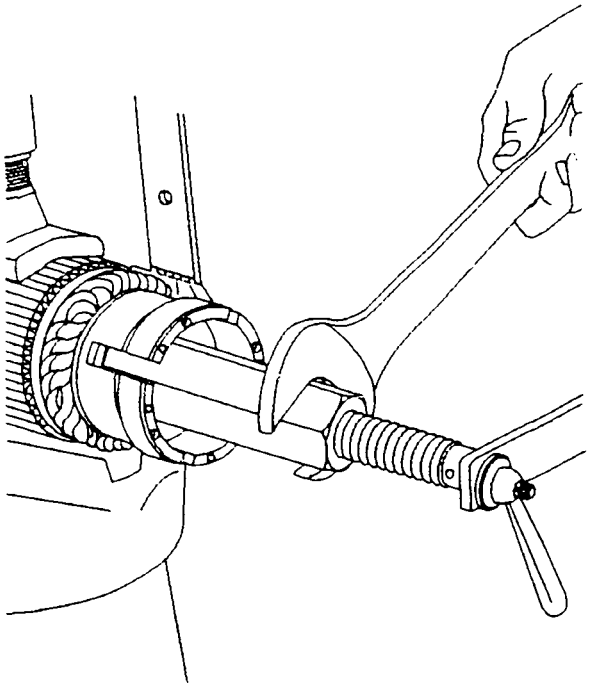
Replacing needle bushing in armature

Removal:
Clamp armature in clamping support.
Use extractor to pull out needle bushing.

Clamping support:	0 986 619 362
Extractor for needle bushing in armature:	0 986 617 233
Spring collet 18.1 mm for needle bushing in armature	0 986 617 240

Continue: III06/1 Fig.: III05/2

KMS00129



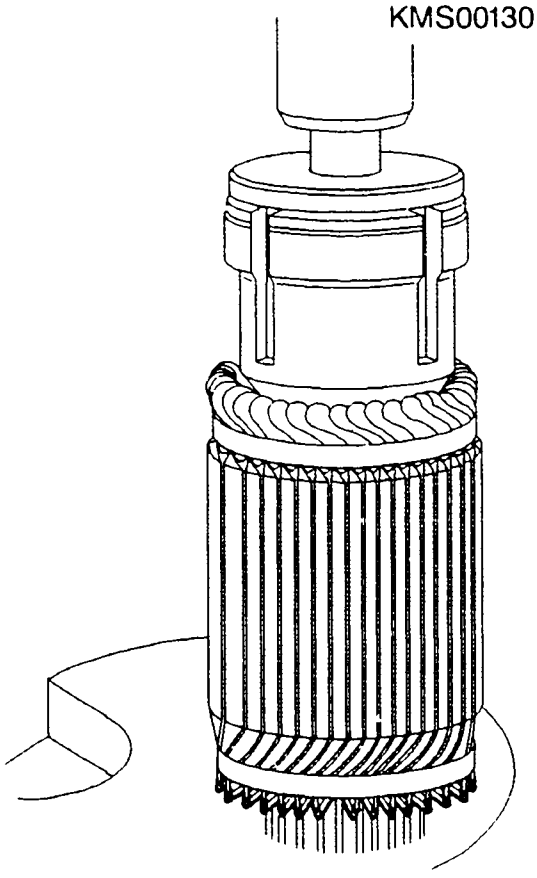
CHECKING AND REPAIRING COMPONENTS

Replacing needle bushing in armature

Installation: Grease needle bushing before pressing it in.
Use pressing-in mandrel to press needle bushing into armature such that needle bushing designation can be seen from outside.

Pressing-in mandrel for needle bushing in armature:	0 986 617 185
Grease VS 10832:	5 932 240 000

Continue: III07/1 Fig.: III06/2



CHECKING AND REPAIRING COMPONENTS

Checking armature for interturn short circuit, ground short and continuity

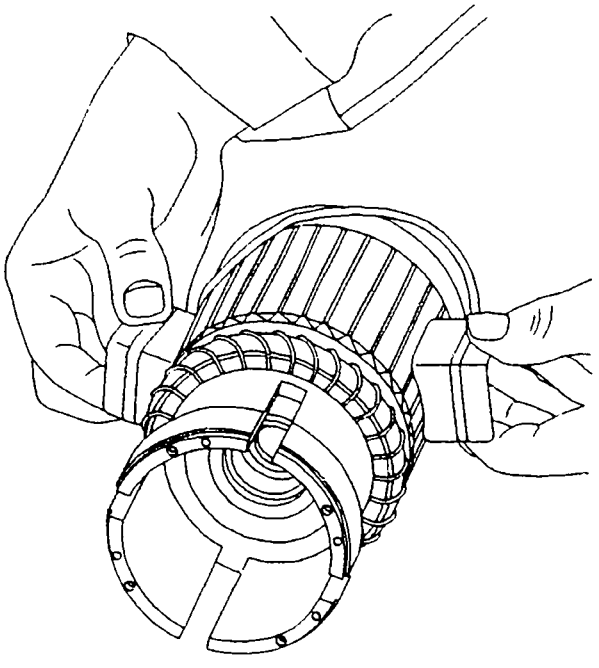
Check for interturn short circuit with tester and test probes. Check for ground short and continuity with tester and test prods.

Interturn short circuit tester:	0 986 619 110
Test prods:	0 986 619 114

Ground short test voltage: 80 V
Continuity test voltage: 40 V

Continue: III08/1 Fig.: III07/2

KMS00131



CHECKING AND REPAIRING COMPONENTS

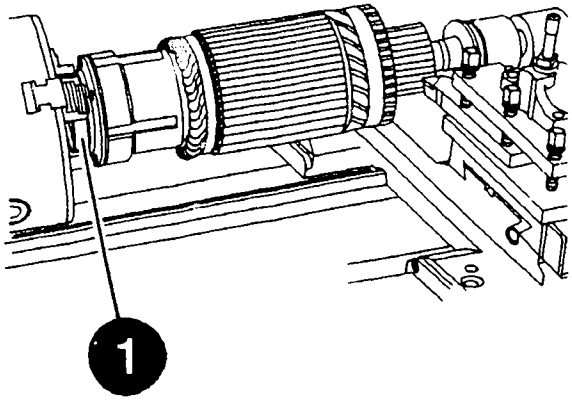
Checking commutator

Check commutator concentricity and turn down if necessary. Note minimum diameter.
To turn down, fit bearing end plate and mount armature in three-jaw chuck using clamping sleeve (1).

Clamping sleeve:	(improvisation)
Minimum diameter:	59,0 mm
Eccentricity	
- Commutator:	max. 0,03 mm
- Laminated core:	max. 0,03 mm

Continue: III09/1 Fig.: III08/2

KMS00132



CHECKING AND REPAIRING COMPONENTS

Checking commutator

ATTENTION: On starting motors produced prior to date of manufacture FD 461 the lamination insulation of the commutator contains asbestos.
Use suitable extraction unit when working. The insulation is asbestos-free on starting motors as of FD 461.

The lamination insulation of the commutator must be sawn out after turning down with a suitable tool.

Continue: III09/2

CHECKING AND REPAIRING COMPONENTS

If commutator saw is employed, use must be made of a suitable extraction unit and the thrust piece for holding the armature.
Turn down commutator again after sawing out and check for interturn short circuit and ground short.
Note diameter.

Thrust piece for holding armature: (improvisation)
Interturn short circuit tester: 0 986 619 110

Minimum diameter: 59,0 mm
Ground short test voltage: 80 V

Continue: III10/1

CHECKING AND REPAIRING COMPONENTS

Checking excitation winding

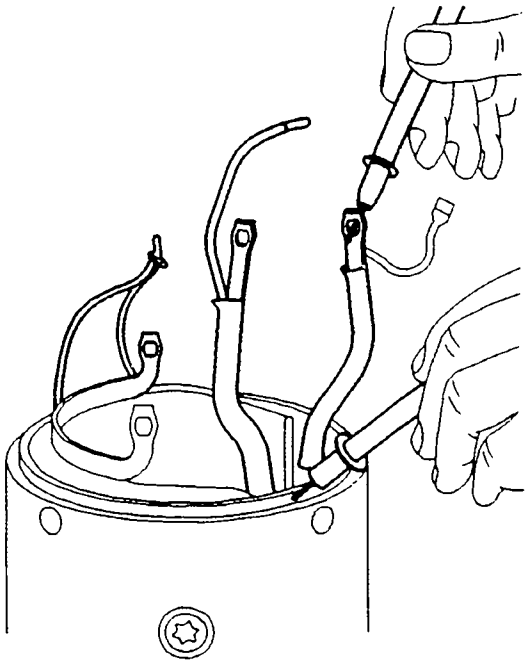
Check each winding for ground short and continuity using tester and test prods.

Interturn short circuit tester:	0 986 619 110
Test prods:	0 986 619 114

Ground short test voltage: 80 V
Continuity test voltage: 40 V

Continue: III11/1 Fig.: III10/2

KMS00133



CHECKING AND REPAIRING COMPONENTS

Checking excitation winding

Use tester to check resistance values.

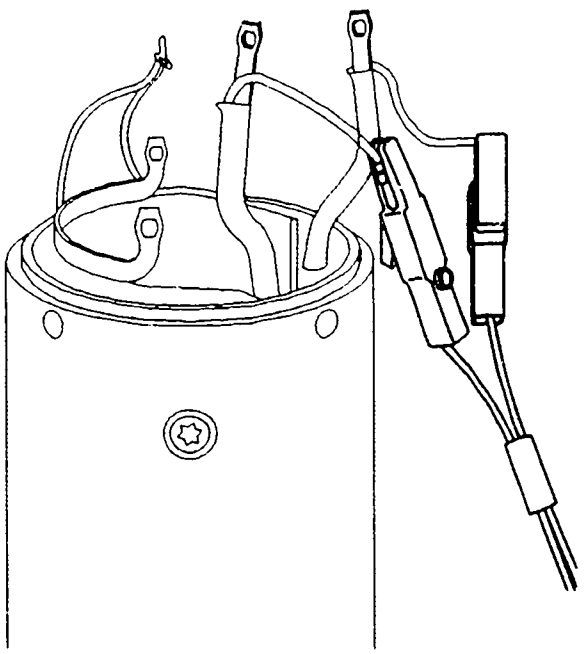
Alternator tester: 0 684 201 200
(or Motortester)

Resistance

Shunt winding:	1960...2160 mOhm
Auxiliary winding:	410... 460 mOhm

Continue: III12/1 Fig.: III11/2

KMS00134



CHECKING AND REPAIRING COMPONENTS

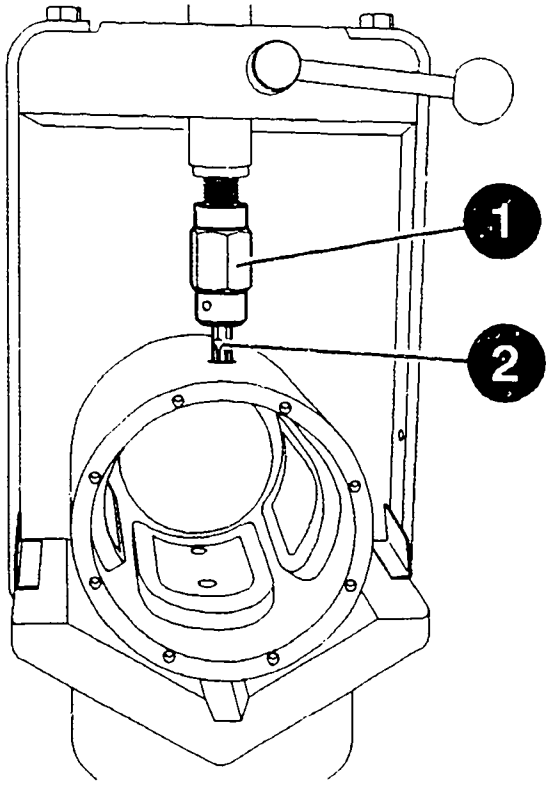
Replacing excitation winding

Replace damaged, scorched or unsoldered windings.
Removal: Place stator frame in clamping support. Mark position of pole shoes. Loosen screws with pole-shoe screwdriver (1) and Torx insert (2). Remove pole shoes and windings.

Pole-shoe screwdriver:	0 986 619 393
Torx T50 bit insert with hexagon 5/16":	comm. avail.

Continue: III13/1 Fig.: III12/2

KMS00135



CHECKING AND REPAIRING COMPONENTS

Replacing excitation winding

Installation: Warm excitation windings before fitting, insert with pole shoes in stator frame and slightly tighten screws.
Pay attention to markings.
Press in driving-in mandrel.

Driving-in mandrel diameter:	101,15 -0,05 mm (improvisation)

Continue: III14/1

CHECKING AND REPAIRING COMPONENTS

Replacing excitation winding

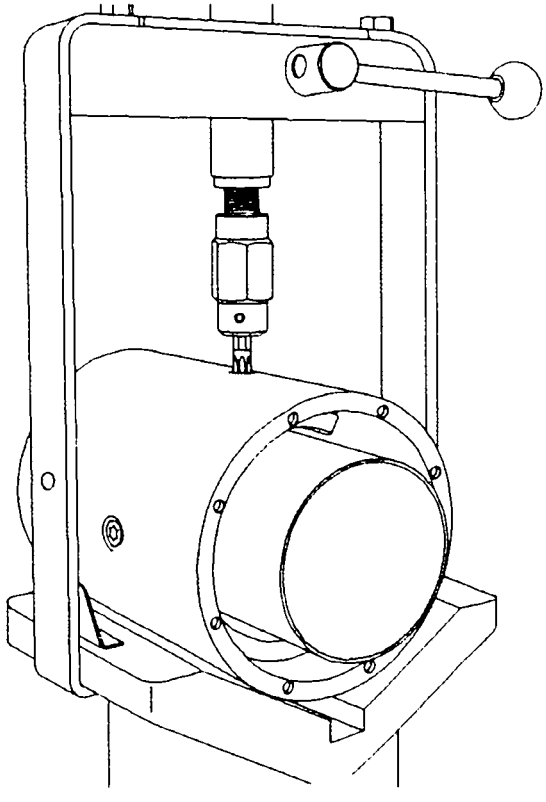
Place stator frame in clamping support.
Finish-tightening pole-shoe screws
and press out driving-in mandrel.

Pole-shoe screwdriver:	0 986 619 393
Torx T50 bit insert with hexagon 5/16":	comm. avail.

Tightening torque Pole-shoe screws:	41...51 Nm

Continue: I01/1 Fig.: III14/2

KMS00136



STARTING-MOTOR ASSEMBLY TABLE

Continue: I01/1

STARTING-MOTOR ASSEMBLY

Assembling multi-plate clutch

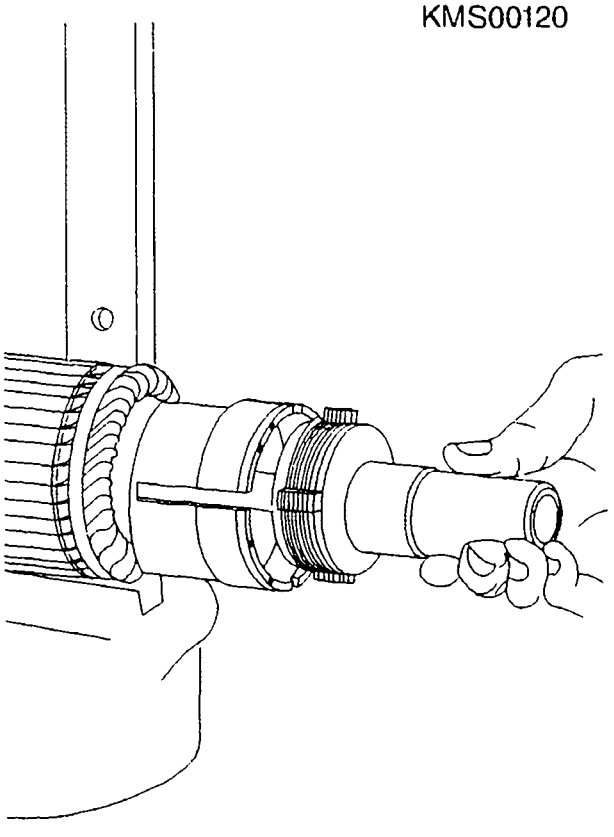
Lubricate as per lubrication chart before and during assembly.

Clamp armature in clamping support. Insert multi-plate clutch in clutch housing.

Clamping support: 0 986 619 362

Continue: III17/1 Fig.: III16/2

KMS00120



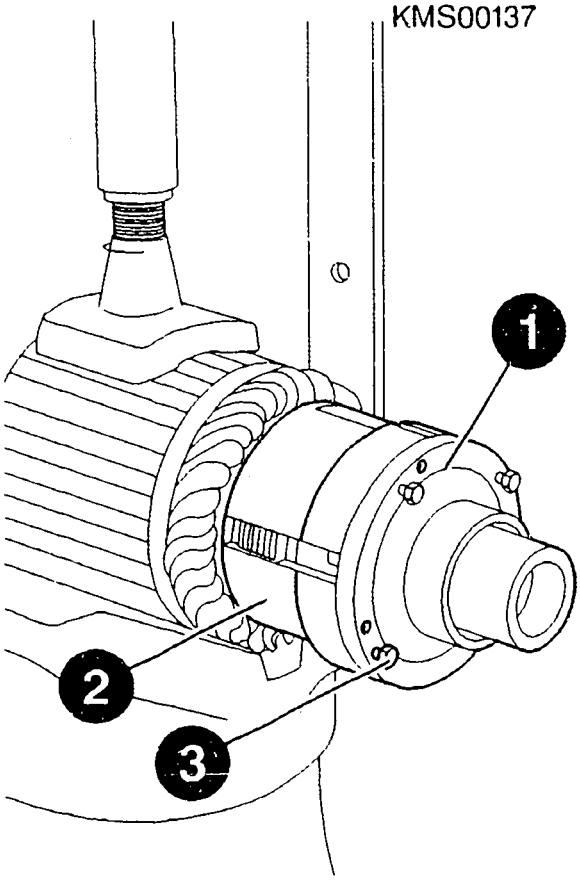
STARTING-MOTOR ASSEMBLY

Assembling multi-plate clutch

Screw bearing end plate (1) to clutch housing (2). Pay attention to asymmetrical arrangement of spring pins in bearing end plate.
Always use new, microencapsulated hexagon bolts (3) of strength class 10.9.
Use torque wrench.

Torque wrench:	comm. avail.
Tightening torque:	7...8,5 Nm

Continue: III18/1 Fig.: III17/2



STARTING-MOTOR ASSEMBLY

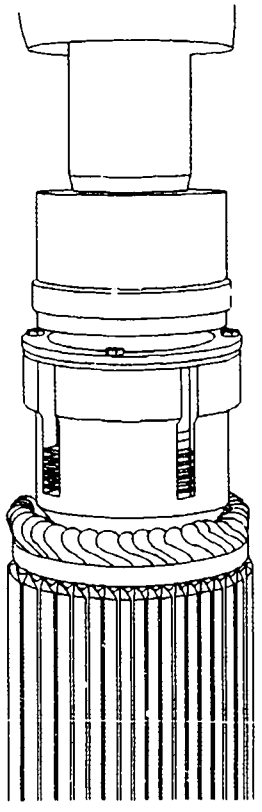
Assembling intermediate bearing

Press deep-groove ball bearing with thrust piece onto bearing end plate.

Thrust piece for pressing deep-groove ball bearing onto bearing end plate: (improvisation)

Continue: III19/1 Fig.: III18/2

KMS00138



STARTING-MOTOR ASSEMBLY

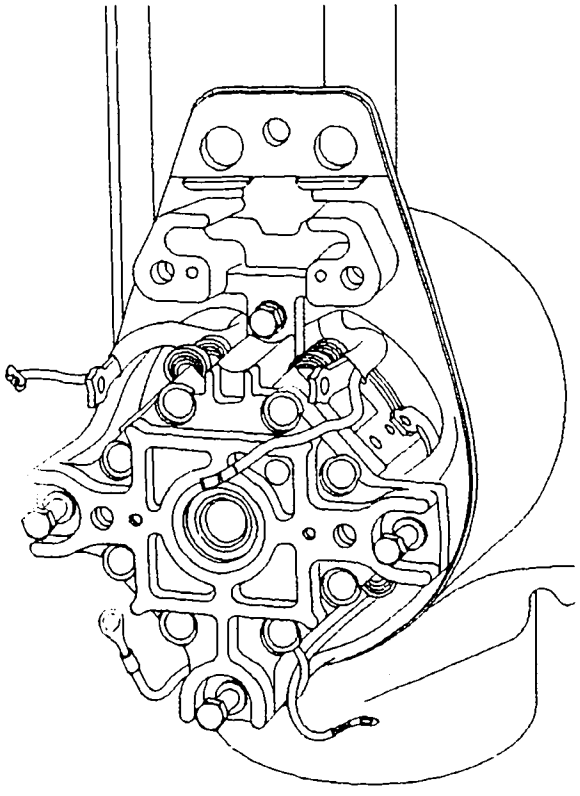
Assembling commutator end shield

Assemble commutator end shield.
Use torque wrench.
When assembling end shield, take care not to damage insulation of protruding winding ends (bend slightly if necessary).

Torque wrench:	comm. avail.
Tightening torque:	7,8...9,7 Nm

Continue: III20/1 Fig.: III19/2

KMS00141



STARTING-MOTOR ASSEMBLY

Assembling drive-end bearing

Clamp stator frame in clamping support. Slip shims onto commutator end of armature shaft. Insert armature into stator frame.

Clamping support: 0 986 619 362

Continue: III21/1

STARTING-MOTOR ASSEMBLY

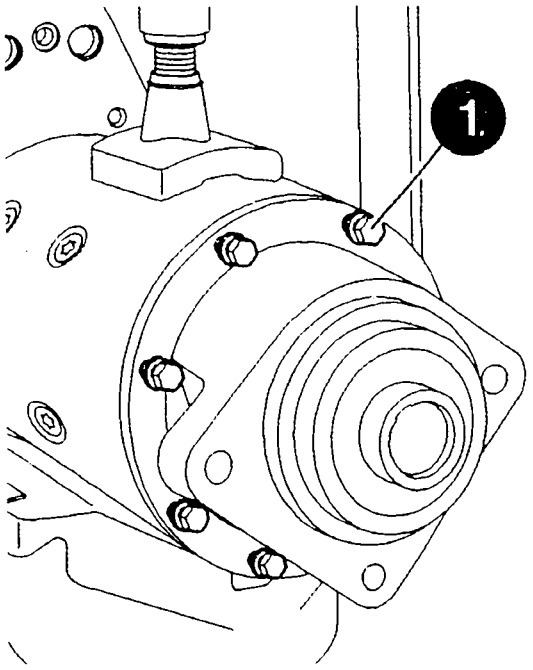
Assembling drive-end bearing

Slip on and secure drive-end bearing. Pay attention to marking. Always use new, microencapsulated hexagon bolts (1) of strength class 8.8.
Use torque wrench.

Torque wrench:	comm. avail.
Tightening torque:	9...11 Nm

Continue: III22/1 Fig.: III21/2

KMS00140



STARTING-MOTOR ASSEMBLY

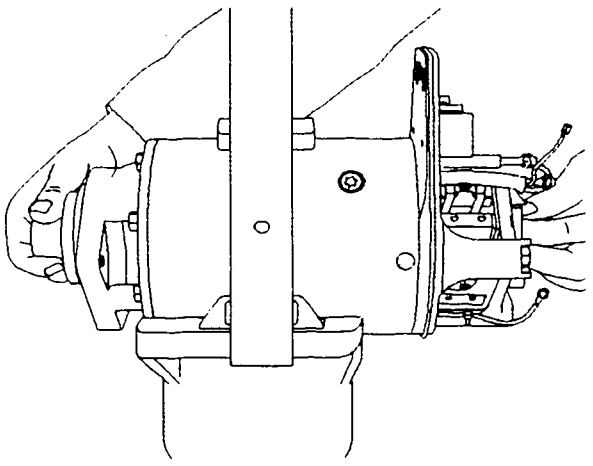
Checking armature axial play

Adjust armature axial play on commutator end only by way of shims.
Check freedom of movement of armature.

Armature axial play: 0,2...0,4 mm

Continue: III23/1 Fig.: III22/2

KMS00142



STARTING-MOTOR ASSEMBLY

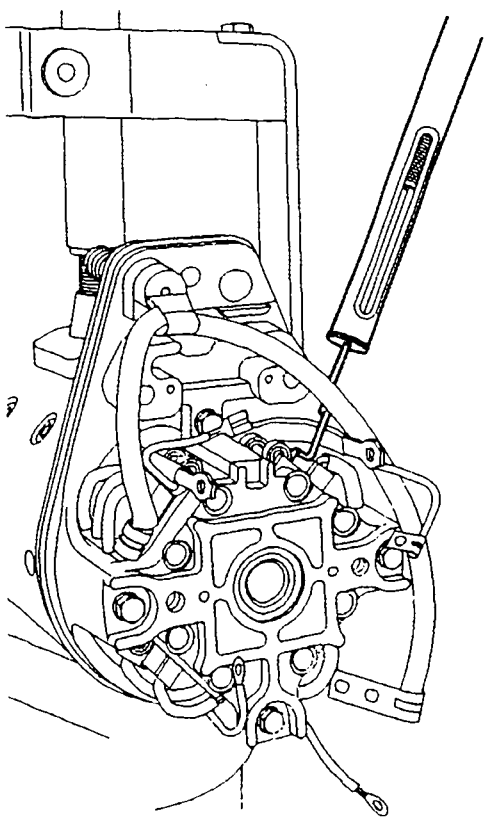
Assembling carbon brushes

Use suitable tool to lift springs and insert carbon brushes. Pay attention to installation position mark.
Use spring balance to check brush contact force.
Insert stud term. 31 with flexible negative bars and insulation in commutator end shield.
Slip on insulating sleeve and O-ring.

Spring balance (0...160 N):	comm. avail.
Brush contact force:	21...22 N

Continue: III24/1 Fig.: III23/2

KMS00143



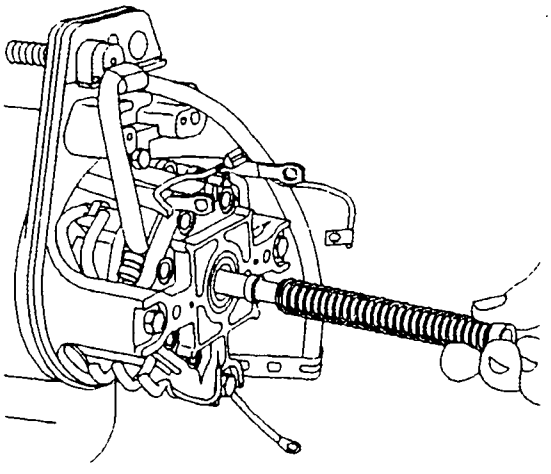
STARTING-MOTOR ASSEMBLY

Assembling engaging shaft

Insert engaging shaft from commutator end into armature.

Continue: III25/1 Fig.: III24/2

KMS00144



STARTING-MOTOR ASSEMBLY

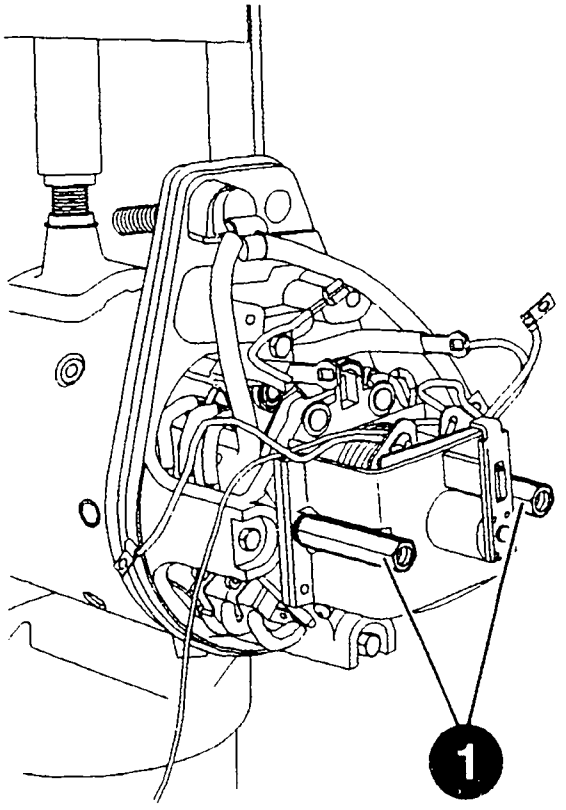
Assembling control relay and starting-motor solenoid

Fit solenoid with securing bolt (1). In doing so, press engaging shaft against spring force into armature shaft. Use torque wrench.
ATTENTION: DANGER OF INJURY
Engaging shaft is spring-pretensioned and shoots out of armature on removing starting-motor solenoid.

Torque wrench:	comm. avail.
Tightening torque:	9,8...14 Nm

Continue: III26/1 Fig.: III25/2

KMS00145



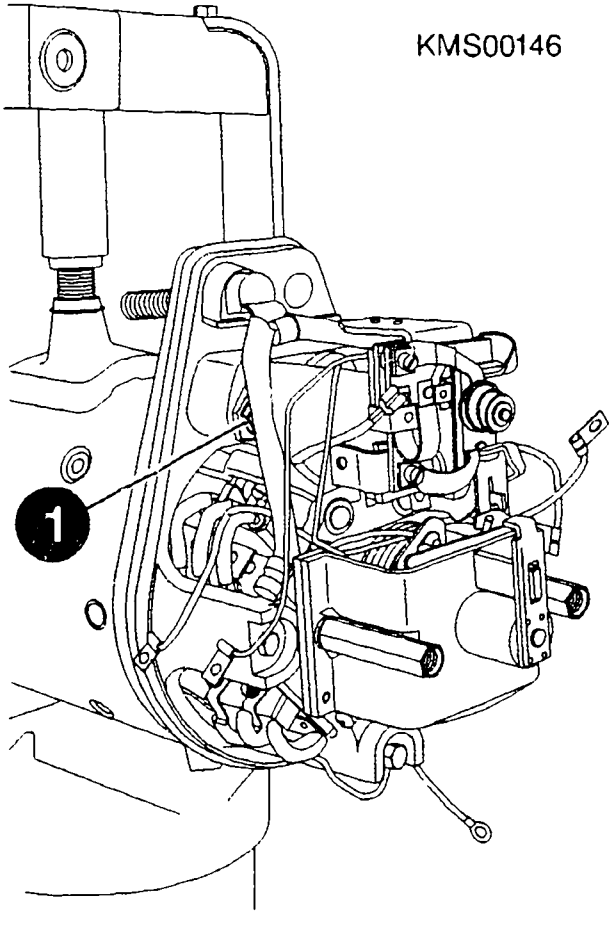
STARTING-MOTOR ASSEMBLY

Assembling control relay and starting-motor solenoid

Insert control relay with positioning pins in holes and secure with hexagon bolts (1).
Use torque wrench.

Torque wrench:	comm. avail.
Tightening torque:	11...16 Nm

Continue: III27/1 Fig.: III26/2



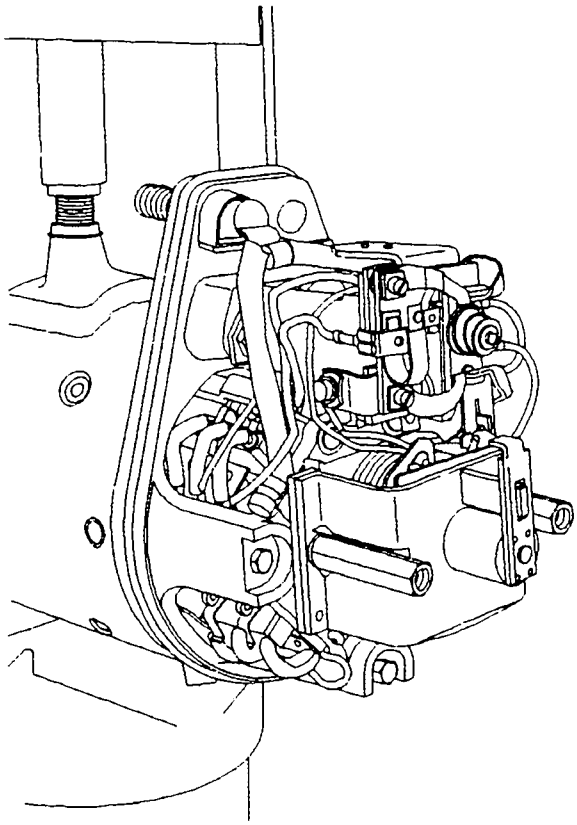
STARTING-MOTOR ASSEMBLY

Assembling control relay and starting-motor solenoid

Make all electrical connections as per terminal diagram at control relay, starting-motor solenoid and carbon brushes. Ends of main field winding must lie flat on connections of control relay.
Bend slightly if necessary.

Continue: III28/1 Fig.: III27/2

KMS00147



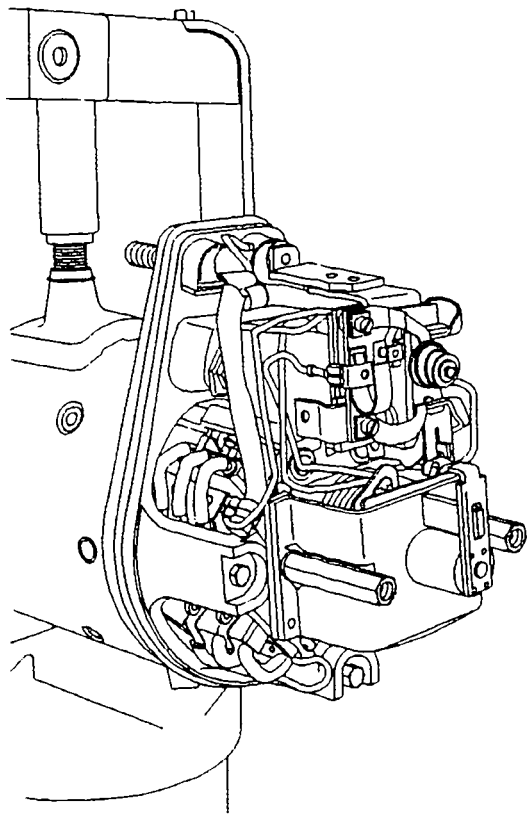
STARTING-MOTOR ASSEMBLY

Assembling term. 30/31/50

Insert stud term. 50 with plastic part in commutator end shield. Slip on insulating sleeve and O-ring.
Solder connections to term. 50.
Insert connecting bar term. 30 in commutator end shield. Slip on insulating sleeve and O-ring.
Push insulating plate from outside over terminal studs. Slip bushings onto terminal studs.
Red: term. 30 ; brown: term. 31; secure spring lock washers and hexagon nuts.

Continue: IV01/1 Fig.: III28/2

KMS00148



STARTING-MOTOR ASSEMBLY

Assembling term. 30/31/50

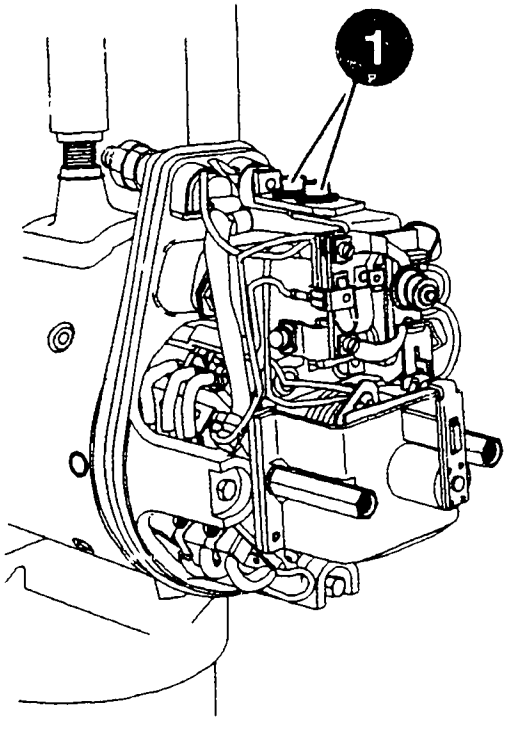
Attach connecting bar term. 30 to control relay and fit insulating caps (1).

Tightening torque

Terminal 30 (M10):	16...20 Nm
Terminal 30 (M12):	25...31 Nm
Terminal 31 (M10):	16...20 Nm
Terminal 31 (M12):	25...31 Nm
Terminal 48 (M5):	2,6...3,5 Nm
Terminal 50 (M6):	3,5...4,5 Nm

Continue: IV02/1 Fig.: IV01/2

KMS00111



STARTING-MOTOR ASSEMBLY

Assembling protective cap

Fit and secure protective cap.
Use new seals for commutator end shield and fastening screws.

Continue: IV03/1

STARTING-MOTOR ASSEMBLY

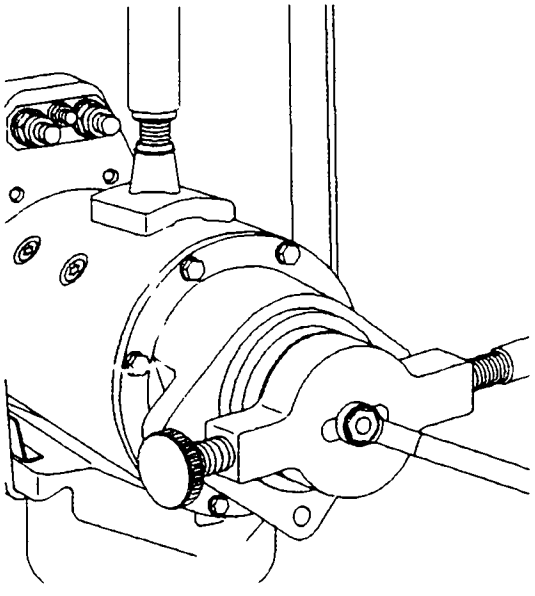
Assembling pinion

Insert pinion in drive spindle and secure with new Unistop nut.
Use torque wrench.
Counterhold with assembly wrench.

Torque wrench:	comm. avail.
Assembly wrench:	0 986 617 198
Tightening torque:	38...43 Nm

Continue: I01/1 Fig.: IV03/2

KMS00110



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Continue: IV04/2

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Continue: I01/1